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PAPR REDUCTION USING TONE RESERVATION METHOD IN OFDM SIGNAL

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ABSTRACT

In this paper, we are going to propose 'Tone Reservation' technique to reduce PAPR (Peak to Average Power Ratio) in OFDM signal using new algorithm. It is less complex and also calculates its own threshold value at the time of communication. It also calculates its PRT signal while other algorithms requiring predetermined threshold and PRT. It modifies the data by 'bit by bit' comparison with a modified copy of itself (algorithm modified) thus scaling the peaks as and providing a decent BER and good PAPR reduction.

INTRODUCTION

OFDM is a combination of modulation and multiplexing which is used in multiple carrier modulation schemes for transmission of data signals due to its high data rate. Here high rate input data gets partitioned into smaller data stream and get modulated using many sub carriers which have the property of orthogonality so that they cannot interfere with each other. The applications of OFDM goes a long way from Digital Audio Broadcasting (DAB), Wireless LAN IEEE 802.11a, IEEE 802.11g, 3G, 4G mobile phone standards to many more. All the above said applications of OFDM are a consequence of various advantages like including spectral efficiency which is very high, robustness to channel fading, immunity to impulse interference, spectral density average which is unique, capacity of handling echoes which are very strong and distortion which is nonlinear in nature and is very low.

Proposed technique based on algorithm section includes the details of our proposed algorithm and how it is different from the available algorithms of the same class. Simulation analysis and evaluation of performance section includes the details of results obtained by our technique and with corresponding graphical representations. Conclusion

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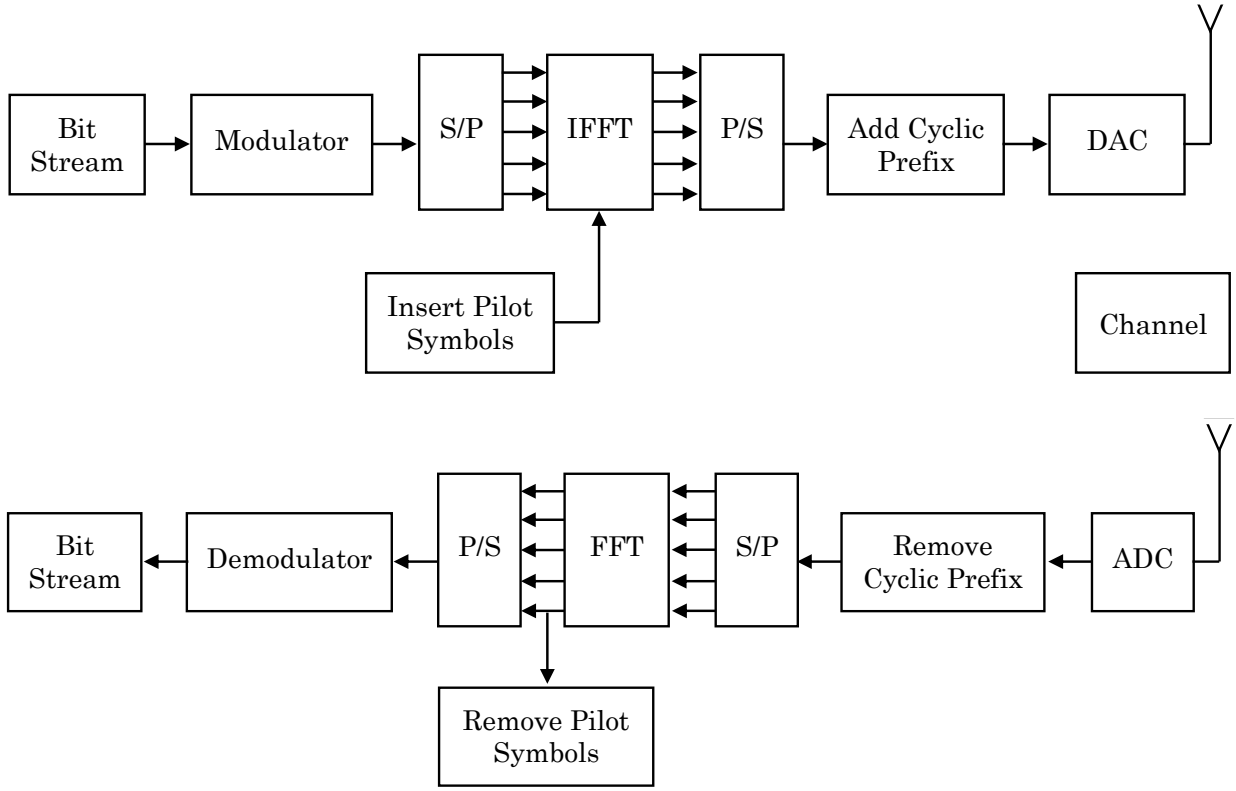
includes what our technique states in a nut shell. The Figure – 1 show the transmission system of OFDM.

Figure – 1: *OFDM Transmission System*



TONE RESERVATION TECHNIQUE AND PAPR CALCULATION

Consider an OFDM system with the specifications: N sub carriers available and data bits to be transmitted

X' = [$X'0$,$X'1$,……'$N-1$] …….. (1)

The OFDM signals are then sampled in real time form and when they are passed through the IFFT block they are formulated as given below:-

$x'n = 1/\sqrt{N} \sum X'KLN-1\ k=0 \times ej2\pi nk/LN$…….. (2)

Here n = 0, 1, 2, ……., LN – 1 and the over sampling factor is represented as L.

Thus the PAPR of the transmitted OFDM data can be denoted by:-

PAPR =$x'n2\ 0 \leq n \leq N-1\ max\ [|x'n|]2$…… (3)

Where the average power of the OFDM data is denoted by the expectation $[|x'n|]2$ and the magnitude at a particular instance is denoted by $|x'n|$.

The technique of Tone Reservation involves reservation of a hand full of sub-carriers which are used to send a counter signal denoted by C' i.e.

C' = [$C'0$, $C'1$, …..$C'N-1$]…….. (4)

So, this signal counteracts the peak values of the original signal X' thus resulting in diminution of PAPR. Let us assume out of total N number of sub- carriers available tone reservation technique books Nr number of sub- carriers for sending the counteracting signal. Thus, out of total N sub- carriers available the signal X' is transmitted through (N - Nr) number of sub- carriers and the rest are used for the transmission of C' signal. This

counteracting signal C' is known as the PRTs. Let us denote a variable Z as the indexes where the PRTs are present.

That is:

$Z = \{i0, i1, \ldots\ldots, iN'r - 1\}$…….. (5)

So, in order to achieve a distortion less signal it is a necessary condition that the two signals i.e. X' and C' avoid overlapping with each other. Thus we can denote a set Z such that among the total number of available sub- carriers N' represents the set $Z = \{i0, i1, \ldots\ldots\ldots\ldots\ldots, iN'r - 1\}$ consisting of Nr sub- carriers for C' transmission and ZC which is the complementary set of Z consisting of (N - Nr) is used for the transmission of the signal X'. Thus in a nut- shell we can state that if the position falls within Z then the instantaneous value of C' gets transmitted and the position falls within ZC then X' gets transmitted. So, mathematically this condition can be represented as:-

$X'K + C'K = f(x) = \{X'K, if k \epsilon ZCC'K, if k \epsilon Z$…… (6)

Thus, we have the new signal where the peaks are reduced and the two signals $X'K$ and $C'K$ clearly distinguished.

Thus it can be demonstrated as:-

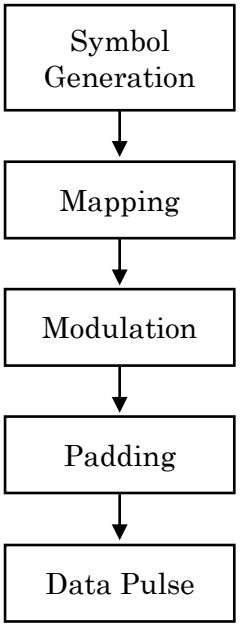
$x''n = x'n + c'n = \sum (X'k + C'K) \times ej2\pi nk/NLN-1\ k = 0$…….. (7)

Thus, the peak to average power of the new and modified signal can be represented as:-

PAPR = $|x'n + c'n\ |2\ 0 \leq n \leq N-1\ maxE[|x'n|]2$…….. (8)

Thus from the above equations we can draw out a conclusion that in order to reduce PAPR.

Figure – 2: *Bit Generation in OFDM System*



SIMULATION ANALYSIS AND EVALUATION OF PERFORMANCE

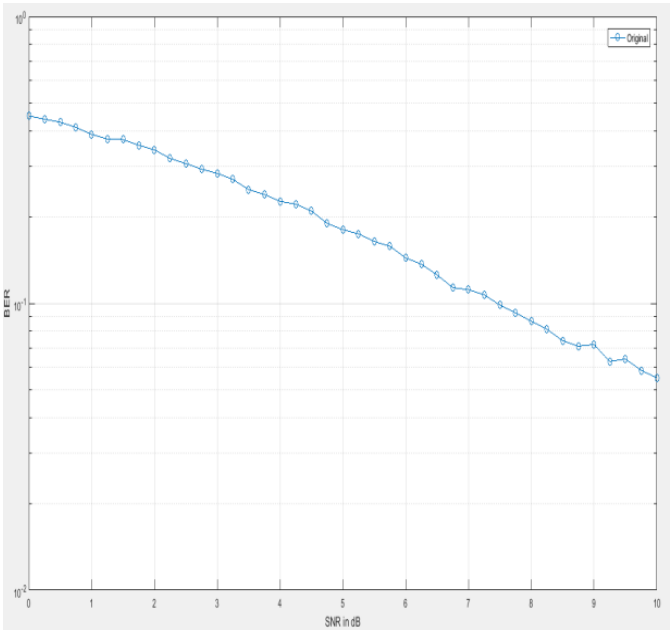
For our method we have used 16 QAM and 256 numbers of sub- carriers along with 4 as the over sampling factor i.e. K. The figure.3 denotes the PAPR reduction. Here a comparison and peak reduction is shown between the original data signal $X'K$and the

modified peak reduced signal $X''K$. Here the blue graph represents the original signal denoted by $X'K$ and the green graph represents the modified signal $X''K$.

By applying our proposed algorithm we have found that the PAPR of the signal gets reduced by a factor of 6.55db when we incorporate the factor 1.5 with median and when we incorporate the factor then a PAPR reduction of 4.9db is observed. However, when we incorporate the factor 1 then the largest PAPR reduction i.e. 7.68db is observed. But a drawback is observed that is the peak values are reduced to such an extent that there is a chance of excess loss of information. So in order to get a balance between the information and the PAPR we took 1.5 into consideration while reducing PAPR of the signal. The various simulation results are shown in below.

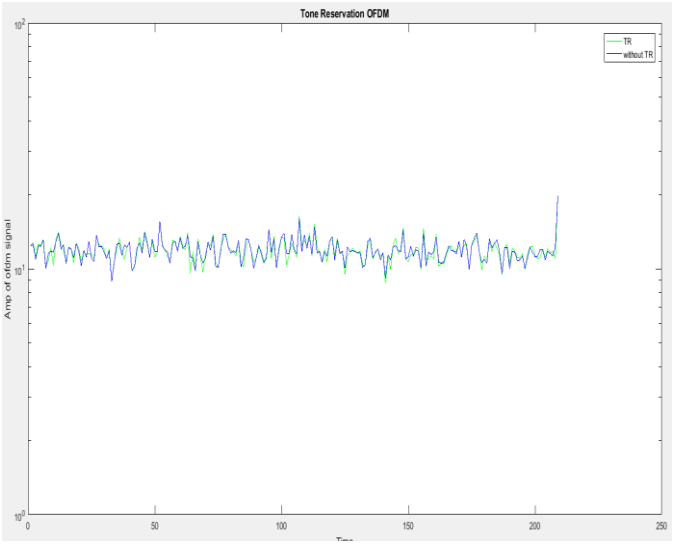
3.1 Bit Error Rate

Figure – 3: *Simulation of Bit Error Rate*



3.2 Comparison of PAPR between Original Signal and Algorithm Applied Signal

Figure – 4: *Tone Reservation by OFDM*



3.3 CCDF

Figure – 5: *Simulation of CDF*

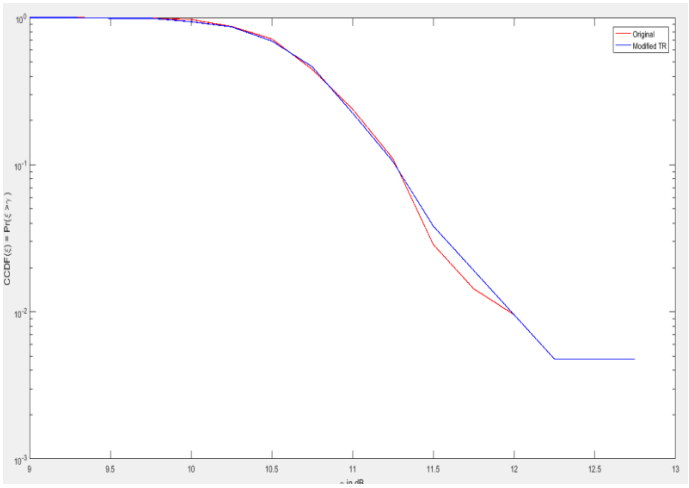
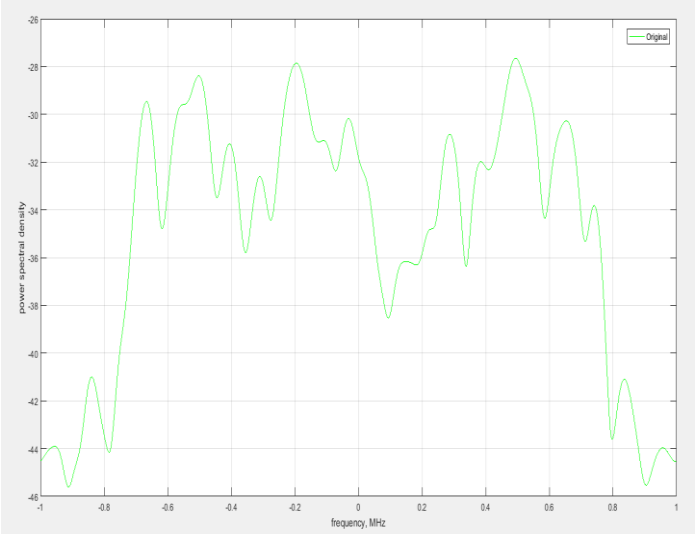
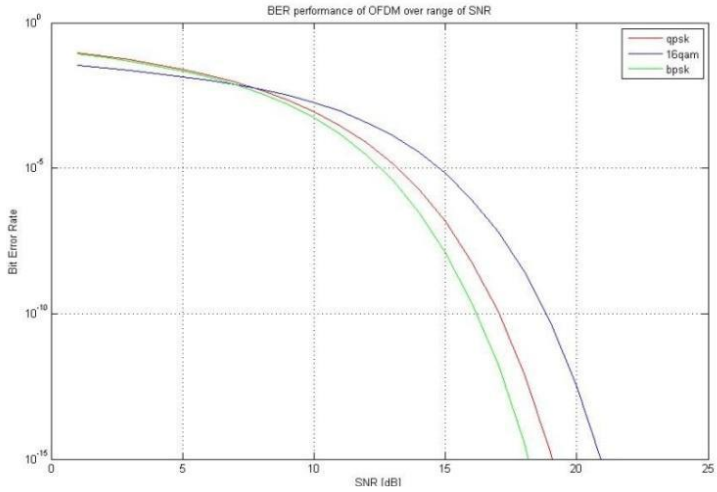


Figure – 6: *Simulation of Power Spectral Density*



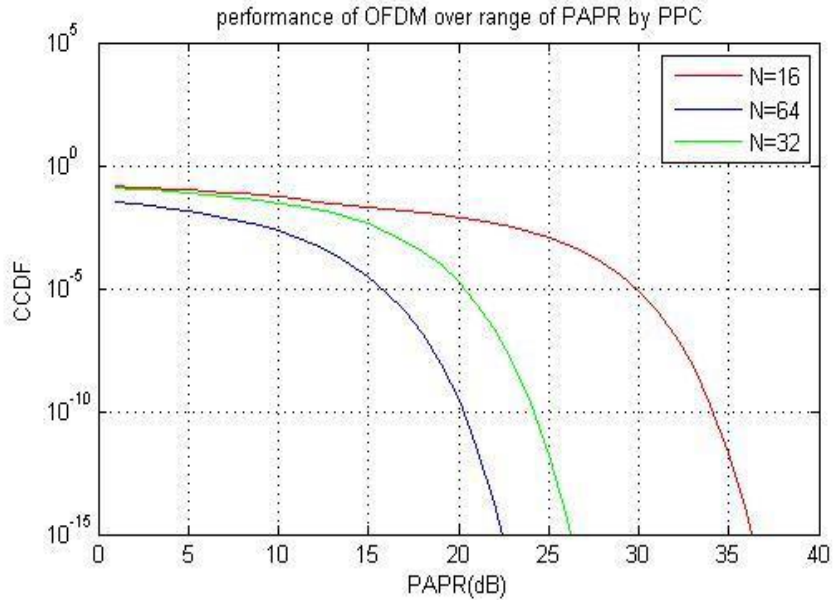
3.4 BER Performance of OFDM Signal with SNR

Figure – 7: *BER Performance of OFDM Signal with SNR*



3.5 Performance of OFDM over PAPR

Figure – 8: *Performance of OFDM over PAPR*



CONCLUSION

Finally, we can conclude that amongst various available methods for diminishing PAPR algorithm based method is one of the most favorable methods as it is less complex in implementation. Among these algorithm based methods we have devised a new algorithm based method which provides its own calculates its own threshold value as well as provides its own counter signal i.e. PRT signal used for PAPR reduction which is in diametric contrast with the other available methods where one has to provide the threshold beforehand as well as to provide a pre-defined counter signal i.e. PRT signal for PAPR reduction. Not only this method maintains low complexity but also it provides a good PAPR reduction by a factor of 6.56 dB while maintaining a good balance between BER and SNR. Thus we can conclude that our proposed algorithm out performs other methods of the same class.

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